NASA TECH BRIEF

Newly Developed Foam Ceramic Body Shows Promise as Thermal Insulation Material at 3000° F

The advances made in the area of aerospace propulsion systems have created urgent requirements for inorganic insulation materials with the inherent capability of insulating at temperatures of +3000° F. The present generation of high specific impulse engines generates severe radiative and convective heating envelopes as well as high vibratory stresses. These conditions dictate the use of inorganic insulators that must fulfill specific requirements such as high melting temperatures, insulating efficiency, oxidation resistance, and high mechanical strength. These general requirements may be used to define the properties of an ideal insulating material for aerospace vehicles. The insulating media must display low density and thermal conductivity, good thermal shock resistance, high melting point, and mechanical strength.

A program was initiated with the specific objective of developing alkali metal peroxide and superoxide blown ceramic foams with lowered thermal conductivity. Cast ceramic bodies, composed of chemically-blown and chemically-bonded zirconia foams, were also formulated and evaluated for their physical and mechanical, thermal, and optical properties.

The results of the program are summarized as follows: An optimized foam ceramic body, designated Z76 (ZrP_2O_7), has been developed and evaluated. Study of the gross properties shows a uniform pore distribution and a narrow range of pore sizes. The as-cast surface of the body exhibited a smooth (matte) skin that was hard, and penetrated by small diameter holes connected to internal pores. Cut surfaces of the body show hemispherical depressions that appear as closed cells. An interesting phenomenon was the arrangement of internal pores into a repeating hexagonal pattern.

The Z76 properties that have been evaluated are:

1.	Density range	0.96–1.80 g/cc
2.	Flexural strength (Modulus of rupture)	237 psi
3.	Compressive strength	731 psi
4.	Thermal shock resistance	Fair to poor
5.	Melting point	3335° F
6.	Thermal conductivity	4.5 BTU/hr °F in/ft^2 at 1550° F
7.	Emittance (hemispherical)	0.78 at 317° F

It was concluded that the Z76 foam ceramic material developed under this program shows promise for use as a thermal insulation material.

Note:

Additional details are contained in *Development of Alkali Metal Peroxide and Superoxide Blown Ceramic Foams*, by E. W. Blocker and R. D. Paul, United Aircraft Corporation, April 5, 1966. This report is available from:

Technology Utilization Officer
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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D. C. 20546.

Source: E. W. Blocker and R. D. Paul
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